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# URANIUM LOSSES FROM THE Y-12 PLANT TO THE ENVIRONMENT

(Y-B92-13 Deleted Revised)

An analysis has been made of the losses of uranium from the Y-12 Plant during the period August 1943 to May 1956. This analysis was made to supply information concerning the history of known and estimated losses of uranium to the environment for Project [redacted] as was requested by the AEC.(1)

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It was necessary to estimate most of the losses from operating experience and the few exhaust-gas analysis data which were available. The best known losses were the discards to the sewer which flows into Poplar Creek; however, these should only be regarded as an estimate with good reliability. For the estimation of these losses, uranium accountability and operating records have been utilized as a basis.

The losses are tabulated in Table I. A description of the effluents is outlined as follows:

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## I. THE ALPHA PROCESS ( PERIOD 1943 TO 1945)

The separation of the isotopes of uranium by the electromagnetic process involved several chemical operations in addition to the physical process. The separation itself was only about 7 - 8% efficient. This meant that most of the uranium had to be recovered and made into new charge material.

The Calutron units were rather complicated structures of metal, largely copper, carbon and ceramics. After use, the various parts of the machine were washed in dilute nitric acid solution. Since the charge material to the unit was $UCl_4$, the washing generated a rather corrosive solution from which the uranium had to be recovered and remade into charge material. Various processes were used at different times, but most of the material was recovered by one in which the iron was removed from the solutions by pH adjustment and filtration.. The uranium was precipitated as the peroxide and the solution was filtered. The filtrates from the peroxide step contained a fair amount of uranium which passed to the sewer. The peroxide was calcined to the trioxide in rotary furnaces from which there were fairly large dust losses. The oxide was converted to the chloride by heating with liquid $CCl_4$ under pressure or by a vapor phase process. The chloride was further purified by sublimation when required. From most of the operations the losses were in the form of solutions. They were drained by the sewer into Poplar Creek.. It is estimated that the air-borne losses could have not been more than a few percent of the total losses from the process. The uranium from carbon parts was recovered by burning the carbon. There was also some dust loss from this process.

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## II. THE BETA PROCESS ( PERIOD 1944 TO 1945)

The purpose of the Beta cycle was to concentrate the product of the Alpha cycle. Because of the enhanced value of the material, all of the operations were much more carefully done. The Calutron units were smaller and more efficient. The chemical recycle, while it had the same objective of reconversion of the unused material to new $UCl_4$ for reuse, was done in a more quantitative manner. The effluents from the various precipitation steps were recovered by solvent extraction and more careful attention was paid to the prevention of dust losses. Even though the total losses were much lower, it is possible that the dust losses were a somewhat higher percentage of the total losses than Alpha.

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(1) Sapirie, S. R., Secret Letter to C. E. Center, May 23, 1956, ORO 78645

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## III. PRODUCT PROCESSING

### A. Beta Product Processing, (Period 1944 to 1947)

The Beta product was collected on carbon parts. These were cleaned of the bulk of the material, which was in the form of a loose powder; and the remaining carbon was burned to insure complete recovery. Because the input to the cycle had to be measured after several processing steps had taken place, the actual losses in this cycle were in some doubt; however, all of the operations were done with great care and the losses are estimated to be low. The collected material was put into nitric acid solution, purified by ether extraction, precipitated as the peroxide, converted to the oxides and made to $UF_4$ with $H_2$ and HF. It is estimated that there were dust losses in these dry operations and they may have been a sizeable percentage of the total losses from the system. Undoubtedly some of the dust losses were never detected in the product cycle and, as a consequence, would have appeared as losses in the Beta separation process.

### B. Building 9212

#### 1. Process Vents from $UF_6$ Reduction, D-Wing, (Period 1954 to Date)

The continuous process for reducing $UF_6$ to $UF_4$ with hydrogen and fluorine had a small amount of unreacted $UF_6$ or $UF_4$ dust remaining in the vent gases after the process gas passed through mechanical filters and chemical traps. The process gas was discharged continually to the atmosphere. Any unreacted $UF_6$ would have been immediately hydrolyzed to $UO_2F_2$ smoke upon contact with moist air.

#### 2. Process Vents From $UF_4$ Preparation by Batch Hydrofluorination, (Period 1945 to Date)

The production of $UF_4$ by this process involved precipitating water solutions of uranium salts with peroxide and reducing the cake with $H_2$ batchwise to the oxide. The oxide was fluorinated batchwise with gaseous HF at elevated temperatures. Dusting was inhibited by passing the vent gases through a porous carbon filter and a neutralizing pot before venting to an exhaust air stack. The effluents from this process were probably as fume or dust from the reduction and fluorination steps.

#### 3. Discards From Chemical Processing to Storm Sewer, (Period 1953 to Date)

These discards primarily consisted of dilute uranium solutions which were uneconomical to salvage and were usually basic in nature. They also contained large amounts of nitrates and fluorides. This sewer emptied into Poplar Creek.

#### 4. Airborne Ventilation Losses From Product Finishing, (Period 1945 to Date)

These airborne losses were discharged principally as uranium oxide, $UO_2F_2$ and $UO_2(NO_3)_2$ fumes, or $UF_4$ dust. Very little information can be furnished about the relative amounts of each which were discharged. They left the building diluted with large volumes of exhaust air.

5. Losses Outside The Plant Area On Shoes and Clothing (Period 1945 to Date)

The losses were largely by technical supervisory, maintenance, and other service personnel who needed to occasionally be in the work areas, but were not sufficiently exposed to contamination to warrant protective clothing. This uranium, primarily as the oxide and nitrate, was gradually carried from the plant in small amounts.

[redacted] PROCESSING

A. Process Vents From $UF_4$ Preparation, (Period 1955 To Date)

The losses occurred in similar manner as Building 9212 process vents in Section III, paragraph B-1, above, [redacted]

B. Airborne Ventilation Losses, (Period 1955 To Date)

These losses occurred in similar fashion as the 9212 ventilation losses in Section III, paragraph B-4, above.

C. Airborne Salvage Area Losses, (Period 1946 to Date)

These losses primarily occurred as dust or fume losses in the form of $UO_2(NO_3)_2$, $UF_4$, $U_3O_8$, $UO_3$ and $UO_2F_2$ diluted with large volumes of exhaust air.

D. Discards From Chemical Processing To Storm Sewer, (Period 1946 To Date)

These discards were solutions from which it was uneconomical to recover the dissolved uranium. This solution contained uranium in many forms; some of these were $UO_2(NO_3)_2$, ammonium diuranate and uranium oxides.

E. Accidental $UF_6$ Release To The Atmosphere

On May 11, 1956, the hydrogen line to the $UF_6$ reduction tower broke. This caused incomplete conversion of the $UF_6$ to $UF_4$. The chemical traps which were provided to trap the $UF_6$ in such an emergency were filled to capacity before the situation was corrected, and $UF_6$ was allowed to escape to the atmosphere. The escaping $UF_6$ was visible as $UO_2F_2$ smoke as it was emitted from the vent stack.

F. Losses Outside The Plant Area On Shoes And Shoes, (Period 1946 To Date)

These losses occured in the same manner as those described in Section III, paragraph B-5, but were smaller because the amount of traffi involved and the throughput was small.

V. NORMAL AND DEPLETED ASSAY PROCESSING

A. Building 9212

1. Airborne Ventilation And Hood Discharge (Period 1948 to 1954)

These losses were primarily in the form of uranium oxide and uranium metal dust from the Sunflower foundry and machining operations. Until September 1953, no filters were provided. The losses for the period were estimated from unaccounted-for material figures.

2. Airborne Ventilation And Hood Discharge (Period 1954 To Date)

The dust was in the same form as from 1948 to 1954, but the losses were larger. The production level increased and the filters installed in 1955 required excessive maintenance and were found to require extensive repair in the Spring of 1955. The air was again being filtered on at least a temporary basis by July 1, 1956 and there has been essentially uninterrupted operation since. From January 1954 to July 1956, there were very probably large losses since little dust was collected compared with the amount now being collected. The exact amount can only be estimated from present recovery figures making adjustments for level of production. The losses during FY-1956 have been estimated from stack gas analysis to be about 0.1 kg per day. A continuous monitor is now being installed on the exhaust stack.

B. Building 9206

1. Combustible Salvage Burning, Period 1948 to 1955)

These losses are primarily airborne uranium oxide resulting from burning combustible salvage. The salvage consisted primarily until December 1955, of an uranium metal and oxide mixture from the 9212 casting operation. This operation has not been conducted in the Y-12 plant since 1955.

2. Discard Of Salvage To Sewer, (Period 1946 To Date)

This salvage was similar in nature to that under Section IV, paragraph D.

3. [redacted] Flush To Sewer, (Period 1955 To Date)

The chips from the machining operation were flushed with water while being crushed prior to briquetting. Most of the flush was sewered in the last 6 months. The uranium was in the form of the oxide.

C. Building 9211

1. Airborne Salvage Burning And Kiln Losses, (Period 1953 To Date)

Combustible organic-material salvage was burned in a Herreshoff Furnace prior to leaching. The exhaust gases from the furnace contain $UO_3$ and $U_3O_8$ dust. The ash was leached and precipitated as ammonium diuranate. This was calcined to oxide in an indirectly fired rotary kiln. Considerable dust losses occurred from this operation. In December, 1955, a scrubber was put into operation which reduced the losses from both operations to about 0.3 kg/day when the salvage burning was being carried out.

2. Airborne Ventilation Losses, (Period 1953 To Date)

These airborne losses were primarily dust and fume as $UO_2(NO_3)_2$, uranium oxides, and ammonium diuranate. The material processed was primarily old salvage which had been in storage.

3. Discards To Sewer, (Period 1953 To Date)

These discards were similar to those described in Section IV, paragraph D.

VI DISCARDS TO DISPOSAL PITS AND BURIAL GROUNDS, (PERIOD 1947 TO DATE)

The basis for the amount of uranium discarded to the burial grounds and disposal pits was based on uranium accountability and operating records. Most of the material was discarded in recent years. The uranium was discarded in a multitude of chemical forms; however, some of these were uranium oxides; uranium nitrate, uranium diuranate and uranium peroxide solutions.

William L. Griffith

WLG:ls

J. L. Waters
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TABLE I

URANIUM LOSSES FROM THE Y-12 PLANT TO THE ENVIRONMENT

Enrichment removed.

| Source | Period | Uranium (kg) | Basis For Estimate |
|---|---|---|---|
| I. Alpha Process | 1943-1945 | 40,000 (0.65% U-235) | Estimated from known losses and unaccounted-for material |
| II. Beta Process | 1944-1947 | 400 (25% U-235) | Estimated from known losses and unaccounted-for material |
| III. Product Processing | | | |
| A. Building 9206 | | | |
| Beta Product | 1944-1947 | 0.4 | Estimated from unaccounted-for material |
| B. Building 9212 | | | |
| 1. Process Vents from $UF_6$ Reduction, D-Wing | 1954 to Date | 0.3 | Estimated from effluent analysis and operating experience |
| 2. Process Vents from $UF_4$ Preparation by Batch Process | 1945 to ~~Date~~ 1952<br>1953 to Date | ~~2~~ 0.5<br>1.5 | Estimated from effluent analysis |
| 3. Discards from Chemical Processing to Sewer | 1953 to Date | 5.2 | Accountability and operating records used as basis |
| 4. Airborne Ventilation Losses from Product Processing | 1945 to ~~Date~~ 1952<br>1953 to Date | ~~3.4~~ 1.9<br>1.7 | Estimated from air sample analysis |
| 5. Losses Outside Plant Area On Shoes And Clothing | 1945 to Date | 1 | Estimated as order-of magnitude |
| IV. [redacted] Building 9206 | | | |
| A. Process Vents From $UF_4$ Preparation | 1955 to Date | 0.1 | Estimated from effluent analysis and operating experience |
| B. Airborne Ventilation Losses | 1955 to Date | 0.5 | Estimated from operating experience in similar operations |
| C. Airborne Salvage Area Losses | 1946 to ~~Date~~ 1952<br>~~1953 to Date~~ | ~~6~~ 0.8<br>~~5.2~~ | Estimated |

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[redacted]

TABLE I (CONTINUED)

URANIUM LOSSES FROM THE Y-12 PLANT TO THE ENVIRONMENT

| Source | Period | Uranium (kg) | Basis For Estimate |
|---|---|---|---|
| IV. [redacted] Building 9206 | | | |
| D. Discards from Chemical to Sewer | 1946 to ~~Date~~ 1952 / 1953 to Date | 2.1 / ~~15.3~~ 13.2 | Accountability records used as basis |
| E. Accidental $UF_6$ Release to the Atmosphere | 5/11/56 | 2 | Measured by difference after clean-up |
| F. Losses Outside Plant Area On Shoes And Clothing | 1946 to Date | 0.5 | Estimated as an order-of magnitu |
| V. Normal and Depleted Assay Processing | | | |
| A. Building 9212 | | | |
| 1. Airborne Ventilation And Hood Discharge | 1948 to 1953 | 1500 | Estimated from unaccounted-for losses |
| 2. Airborne Ventilation and Hood Discharge | 1954 to Date | 5,000 to 10,000 | Estimated from present recovery figures. (Losses since July 1 1955 is approximately 0.1 kg/day) |
| B. Building 9206 | | | |
| 1. Combustable Salvage Burning | 1948-1955 | 3,200 | Estimated from operating experience |
| 2. Discards From Salvage to Sewer | 1946 to Date | 1,435 | Accountability records used as basis |
| 3. [redacted] Flush to Sewer | 1955 to Date | 60 | Estimated from operating experience |
| C. Building 9211 | | | |
| 1. Airborne Salvage Burning and Kiln Losses | 1953 to Date | 120 | Estimated to December, 1955; calculated from effluent analysis December 1955 to Date |

TABLE I (CONTINUED)

URANIUM LOSSES FROM THE Y-12 PLANT TO THE ENVIRONMENT

| | Source | Period | Uranium (kg) | Basis For Estimate |
|---|---|---|---|---|
| C. | Building 9211 | | | |
| | 2. Airborne Ventilation Losses | 1953 to Date | 10 | Estimated from operating experience |
| | 3. Discards to Sewer | 1953 to Date | 900 | Accountability records used as basis |
| VI. | Discards to Disposal Pits and Burial Grounds | 1943 to Date | 9,000 | Accountability and operating records used as basis |

[redacted]

Note 1. The material lost varied in composition from diffusion plant tails assay to natural abundance assay.

Note 2. The material lost varied in composition from diffusion plant tails assay [redacted]